Table of Contents

M ENGINES

Model: E39 M5, E52 Z8

Engine: S62B50

Production Date: 2000 MY (Starting with M5) to Present

Objectives of The Module

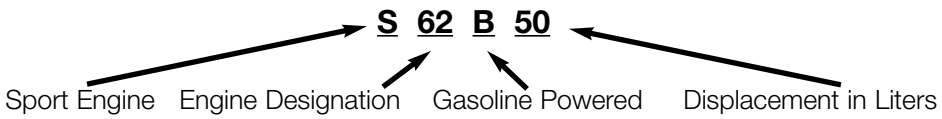
After Completing this module, you will be able to:

- Identify camshaft markings and correct “timing”.
- Explain the VANOS operation.
- Identify piston markings for correct installation.
- Explain the VANOS oil flow circuit.
- Understand the VANOS oil pump operation.
- Identify the intake air system components.
- List the function of the Scavenge Oil Pumps and how they affect oil pan removal.
- Identify the special tools used to perform the VANOS function test.
- Describe where the fuel pressure is tested on the E39 M5 and what the nominal pressure is.
- List what the flywheel mounted incremental wheel is monitored for.

S62B50 Engine

Purpose of The System

The S62B50 engine is an eight cylinder “90º V arrangement” powerplant. This 4941 ccm displacement engine is used worldwide. The engine designation is:



The S62 engine design provides:

1.	**Everyday Driveability**	**5.**	**Economic Operation**
2.	**Reduction in Weight of Engine Components**	**6.**	**Increased Output (to previous M5)**
3.	**Enviromental Compatability**	**7.**	**High Performance**
4.	**Greater Speed Range**	**8.**	**EDR (Electronic Throttle)**

The S62B50 is a 4-valve per cylinder dual VANOS naturally aspirated engine with high torque and high-rev concepts. High torque is developed by a large volume engine at low engine rpm and a long total gear ratio. High-rev is achieved with a small displacement “lightweight” (internal components) engine and short total gear ratio. This powertrain provides the best of both worlds by using a 5 Liter 32 valve V8 configuration coupled to a 6 speed manual transmission.

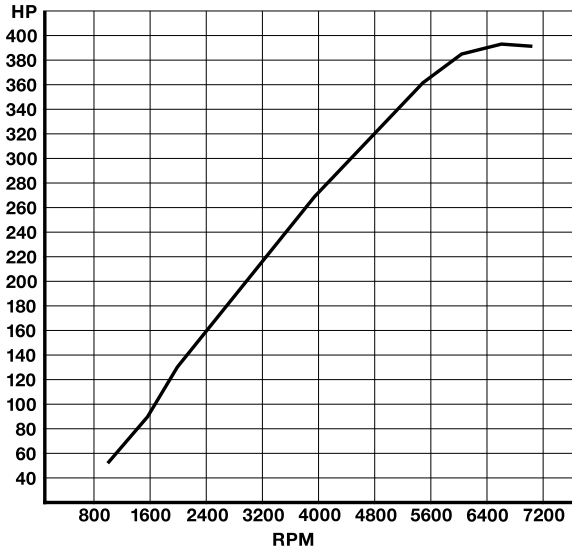
Power Output for the S62:

1. 394 hp at 6600 rpm
2. 500 Nm of Torque at 3800 rpm

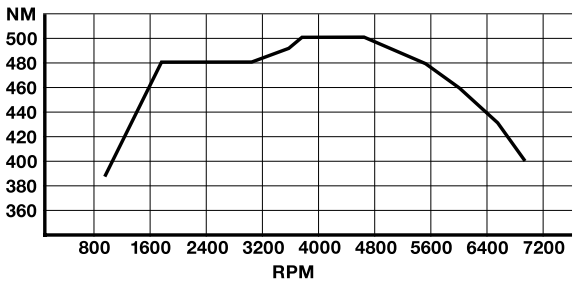
Technical Data

Engine Management	**MS S52**
Effective Displacement (CCM) Design / Valve Per Cylinder	**4941 90º V8 / 4**
Bore / Stroke (mm)	**94 / 89**
Maximum Engine RPM	**7000**
Power Output (hp)	**394 hp**
Weight-to-Power Ratio (kg per hp)	**4.23 / 4.5**
US Torque (Nm per rpm)	**500 @ 3800**
Compression Ratio	**11.0 : 1**
Fuel	**Premium Unleaded**
Valve Diameter	
Intake / Exhaust (mm)	**35 / 30.5**
Stem - Intake / Exhaust (mm)	**6.0 / 6.0**
Valve Lift	
Intake / Exhaust (mm)	**10.3 / 10.2**
Valve Clearance	
Automatic Hydraulic Compensation	
Camshaft Spread Angle	
Intake (degrees)	**74 - 134**
Exhaust (degrees)	**76 - 136**
US Emission Compliance	**TLEV**

S62 power



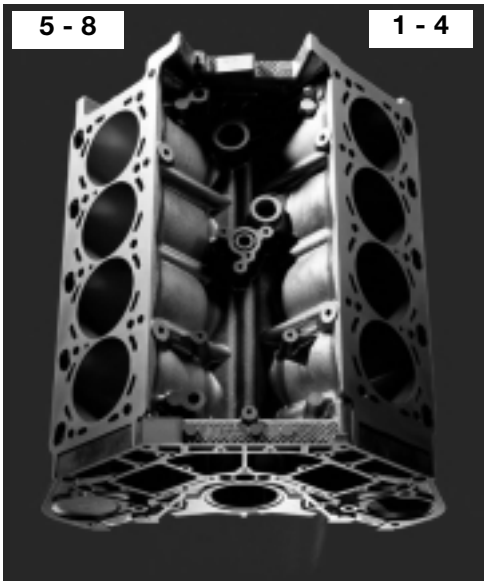
S62 torque



System Components

Engine Block

Cylinder Bank Numbering From Engine Front

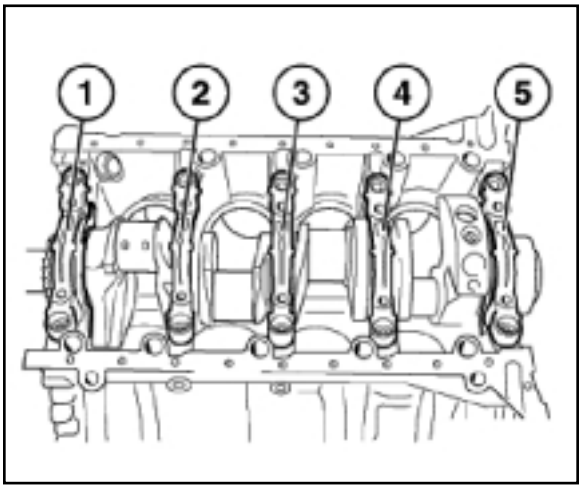


The S62 engine block is manufactured from Alusil as aluminum alloy pressure die-casting. *The cylinder walls are finished by an etching process only.*

The water cooling passageways of the block incorporate a connection in the “V” of the block for an oil/water heat exchanger.

The bore of the block is 94 mm. This along with a stroke of 89 mm gives the S62 engine a displacement of 5 liters. There is 3 mm between the cylinder bores of the engine. The “bare” block weighs approximately 71lbs. (32 kg.)

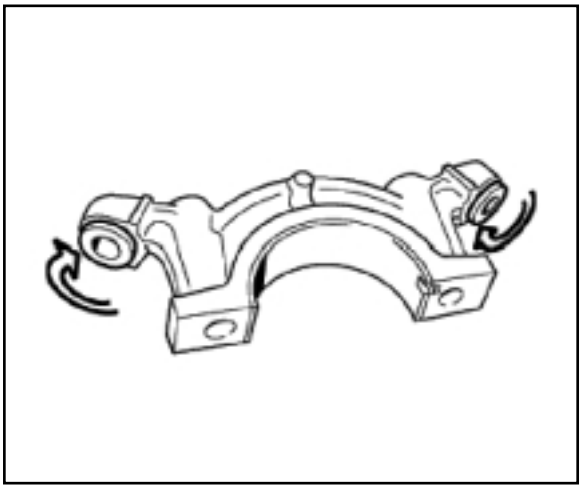
Crankshaft and Bearings: The crankshaft is forged steel with five main bearing journals (70 mm diameter) and the thrust bearing on number five journal.



The S62 bearings are identified by the “triple classification” system. The bearing shell thickness is marked by “notches” in the crankcase and paint markings on the counterweights of the crankshaft (refer to the Repair Instructions for details).

Bearing Clearance:

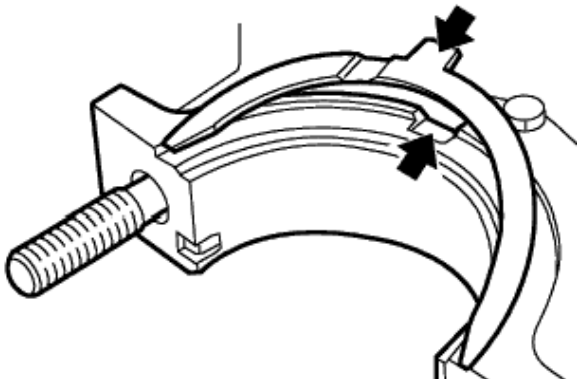
1. Main 0.025 - 0.050 mm
2. Thrust (end play) 0.085 - 0.257 mm



The main bearing caps are secured by four bolts each. The outer bolts are “splayed” (angled) out to the block adding greater strength and support.

The adjustable hex head must be threaded in for installation and then “preloaded” to the block (refer to the Repair Instructions for details).

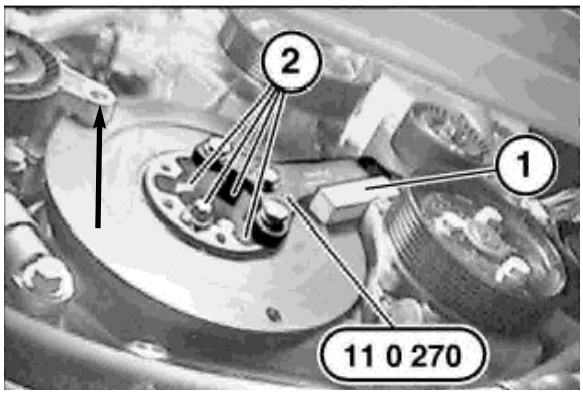
The thrust bearing (#5) is constructed of two radial shells and four shims (example shown on the right).



The shim tab must align with the notch in the bearing cap.

Refer to the Repair Instructions for details on installing the shims in the engine block.

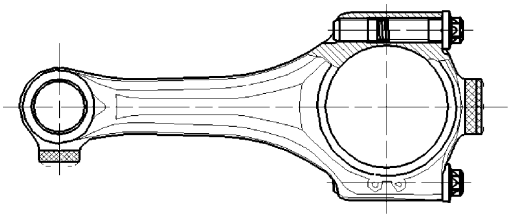
The torsional vibration damper is specifically designed for the higher engine rpm.



The damper is secured by 4 “stretch” bolts (#2 in the diagram, one time use only) which must be angle torqued (refer to Repair Instructions and Technical Data).

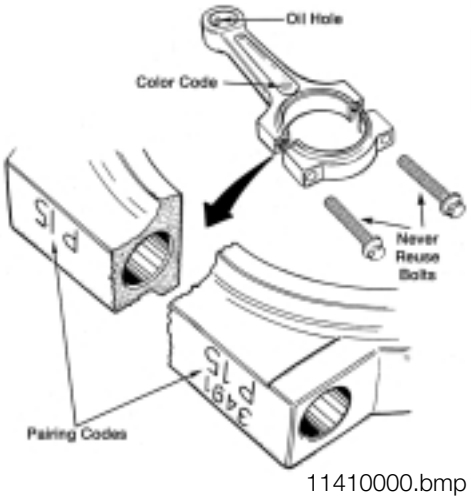
Note the installation location for the crankshaft postion locating special tool (arrow).

Connecting Rods and Bearings: The S62 uses reinforced forged steel “cracked” connecting rods with a 53 mm journal diameter.



The “cracked” connecting rod refers to the cap which is split off leaving rough surfaces on both the cap and the rod.

Centering of the cap on the rod is carried out through the structure of the split which eliminates the alignment sleeves. Pairing codes are stamped into the rod to ensure proper installation of the cap.



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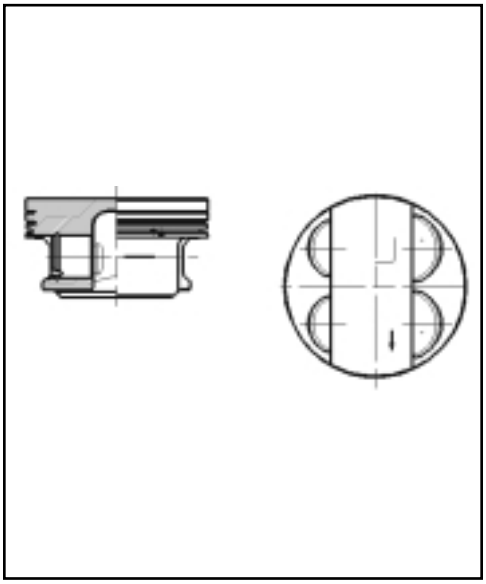
The S62 connecting rods are weight-optimized (+/- 4 grams). Only one set of connecting rods (the same weight class) is available to maintain balance.

The connecting rod bolts are “stretch” type (one time use only) which must be angle torqued (refer to Repair Instuctions and Technical Data).

Pistons and Piston Rings: The S62 uses short skirt design pistons that are coated with a Ferrostan/tin plating for use with the Alusil block. The piston diameter is 94mm.

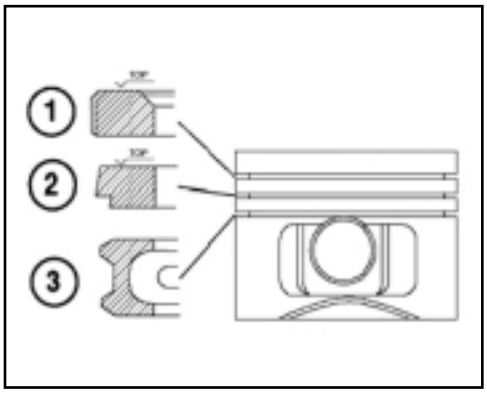


The pistons are cooled with oil spray jets, mounted in the crankcase. The compression ratio is 11.0 : 1 and requires premium unleaded fuel for optimum performance.

The pistons for cylinder bank 1-4 are different from cylinder bank 5-8 due to the wrist pin off set. The relevant cylinder bank number is engraved into the piston crown using laser technology.

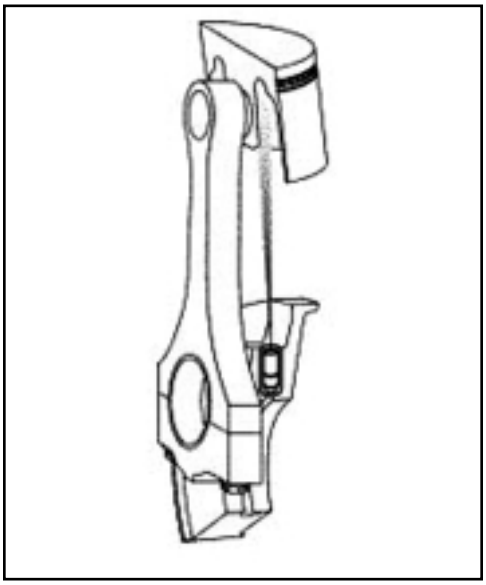
Piston Rings:

1. Compression Ring 1 = 1.2 mm Height
2. Compression Ring 2 = Taper Face 1.5 mm Height
3. Oil Control Ring = Bevelled, Spring Loaded 2 mm Height



A Special Tool (ring compressor) is required to install the pistons.

The pistons are cooled by oil spray nozzles that are bolted into the crankcase.



The nozzles are “tapped” into the main oil gallery and delivers a constant oil spray to the underside of the pistons.

Notes: _____

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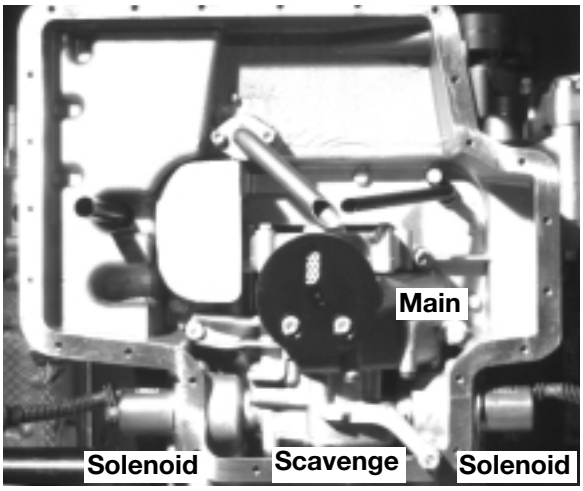
Engine Oil System

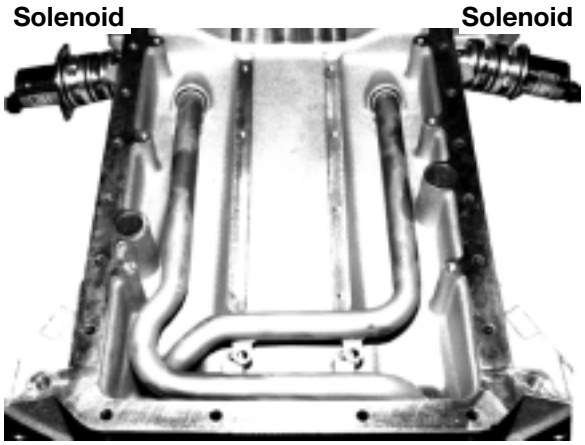
The oil supply system of the S62B50 engine is specifically designed for the M5 and Z8. Due to the sport nature and the ability for high speed cornering (transverse acceleration) of up to 1.2g, the engine oil could be forced (and trapped) into the outer edge of the cylinder head and the rear area of the oil sump.



The main oil pump function is to supply the engine with the required volume of oil for all of the lubrication needs.

To prevent oil starvation from occurring during these driving situations, two additional scavenging oil pumps are installed within the main oil pump housing (integral unit).

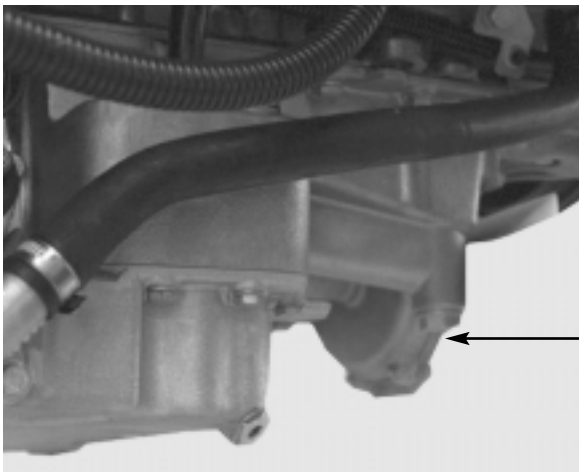
The two additional pumps only supply the oil sump with the scavenged oil.



Each additional oil pump incorporates a *solenoid changeover valve* that is connected to two scavenging tubes routed to the rear section of the oil pan and the outer edge of the cylinder head.

The scavenging tubes in the oil pan crossover so that the right side pump draws from the rear left side of the pan and the left pump from the right side of the pan.

The solenoid changeover valves must be removed before attempting to remove the oil pan. The valves insert directly into the scavenge pump housing through the oil pan.

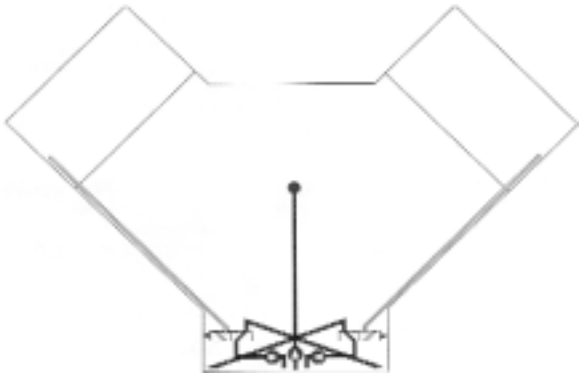


The upper oil pan for the Z8 is been modified due to the engine and crossmember “clearance” relationship.

The upper oil pan is contoured around the oil pump drive at the front of the engine (arrow).

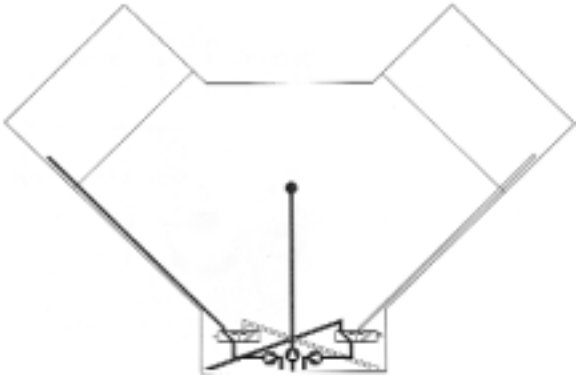
Scavenge Oil Pump(s) Operation: While driving straight ahead, the two oil pumps draw oil from the rear of the oil pan to supply the main oil pump pick up.

The solenoids are de-activated in this situation.



When cornering at forces > 0.9g, one solenoid will be activated by the ECM to draw oil from the cylinder head while the second solenoid will continue to draw oil from the rear of the pan.

The ECM receives the signal from the DSC Control Module (based on cornering G-force) over the CAN Bus line.

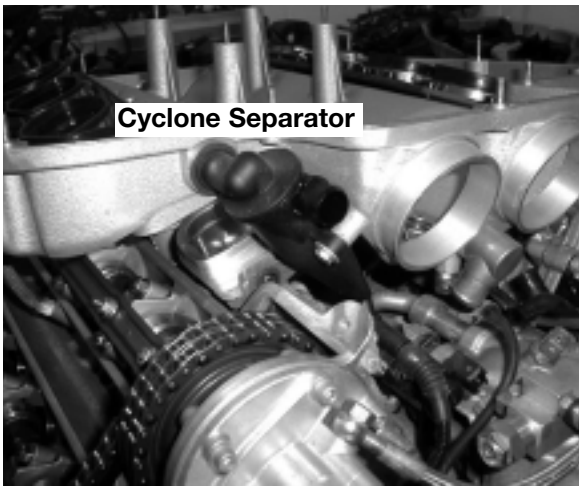


Oil Cooling: The S62 engine is equipped with an oil-to-coolant heat exchanger. It is mounted in the “V” of the block and serves to heat the oil during engine warm up and cool the oil during normal driving. Oil and coolant passageways are cast into the block. Formed “O” rings are used to seal the the heat exchanger. The coolant return is through external pipes back to the thermostat housing.

A differential pressure control valve is integrated into the heat exchanger on the oil side. The valve opens an oil bypass in the event that the exchanger should become clogged or at very low start temperatures. This ensures that the engine will receive sufficient lubrication under all driving conditions.

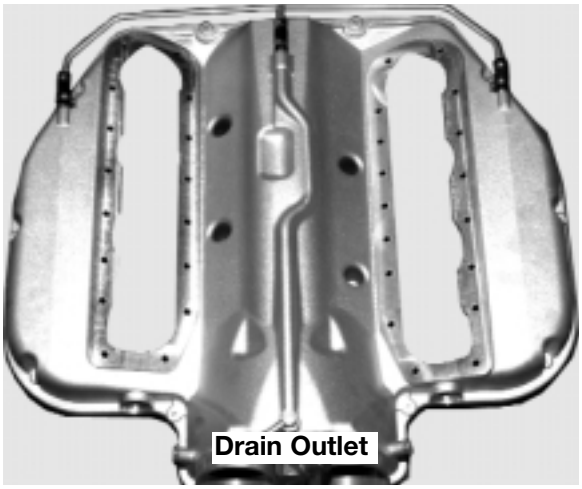
Crankcase Ventilation

The crankcase blow-by vapors are “purged” by intake manifold vacuum. The blow-by vapors flow into the intake through two cyclone separators.



The separators are mounted at the left and right sides of the intake manifold. The oil condensates are separated and flow directly back to the oil sump through feed/return hoses into the front timing case covers.

The crankcase ventilation system is completely sealed. *Care must be taken when reinstalling the cyclone separators in the intake manifold to ensure that the radial seal is fully seated.*

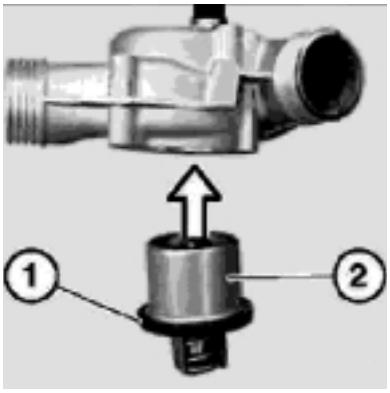


If oil collects in the intake manifold, drainage is provided from two points at the back of the intake manifold lower plenum.

The drainage points “tee” into an integral return passage cast in the intake manifold base as shown. An outlet fitting at the front of the manifold connects to a drain hose that allows the oil to drain back to the crankcase.

Engine Cooling

The S62 coolant flows from the water pump into the block. From here it passes through the heat exchanger and cylinder heads. The coolant cross flows through the cylinder heads.

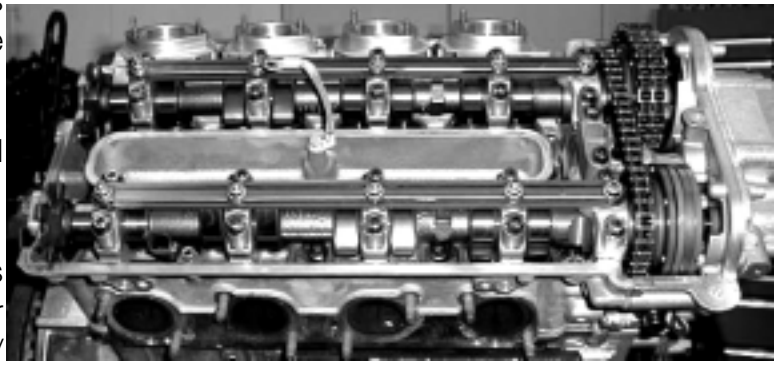


The coolant returns from the heat exchanger and two return pipes from the cylinder heads back into the thermostat housing. Vehicle heating is also taken from the coolant return pipes in the “V” of the block and returns back into the water pump housing.

The S62 engine uses a conventionally heated thermostat (2) that opens at 79 ° C and is mounted on top of the waterpump housing.

Cylinder Heads

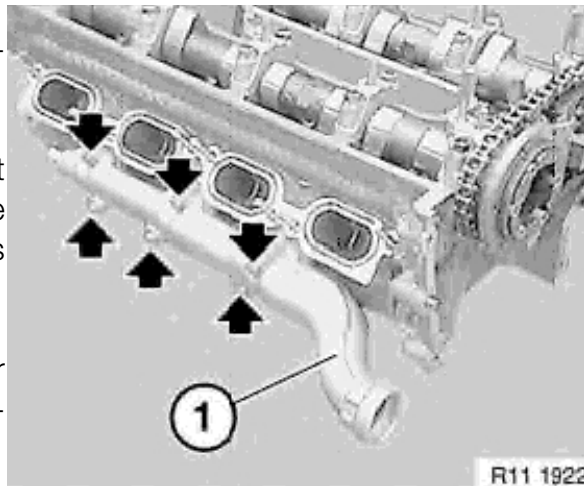
The S62 features aluminum cross-flow cylinder heads designed as single components that house the camshafts and valve train.



The four valve (per-cylinder) head is a single piece construction.

The camshaft bearing journal caps are machined with the cylinder head and are marked intake/ exhaust and numbered for location.

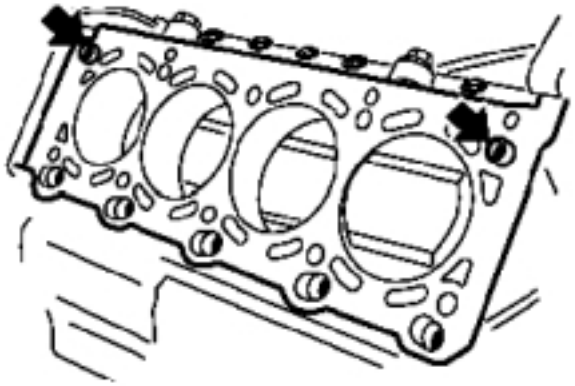
HVA (hydraulic compensators) are used to actuate the valves. *Valve adjustment is not required.*



The cylinder head uses a cross flow coolant design. The coolant enters from the block on the exhaust side and exits through three openings between the cylinders on the intake side.

The coolant returns through an external water manifold (1) on each cylinder head to the thermostat housing.

The spark plugs are centrally located in the combustion area for the most effective power and reduced emission outputs.

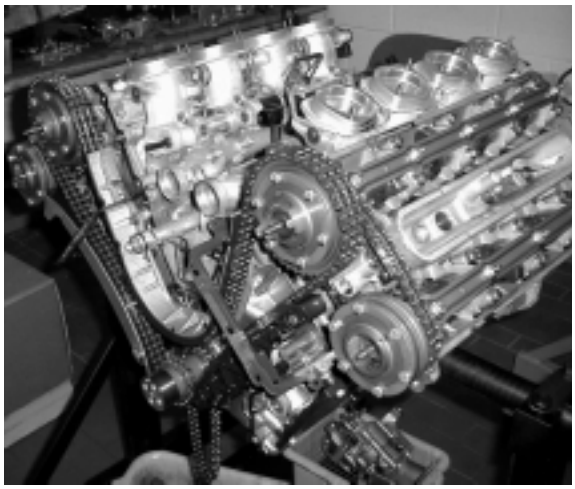


Refer to the Repair Instructions using the Special Tools for cylinder head pressure testing.

The cylinder head gasket is a steel version.

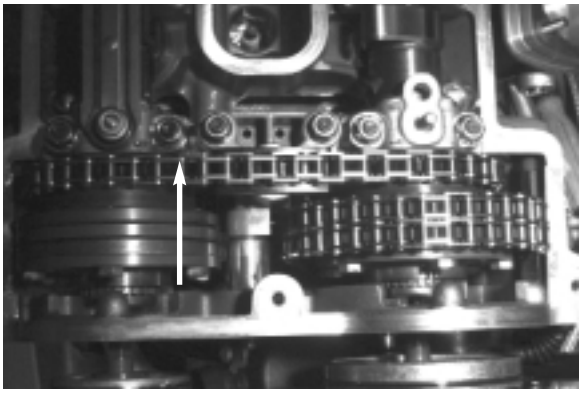
Note: Cylinder head machining is not permitted.

Valve Train



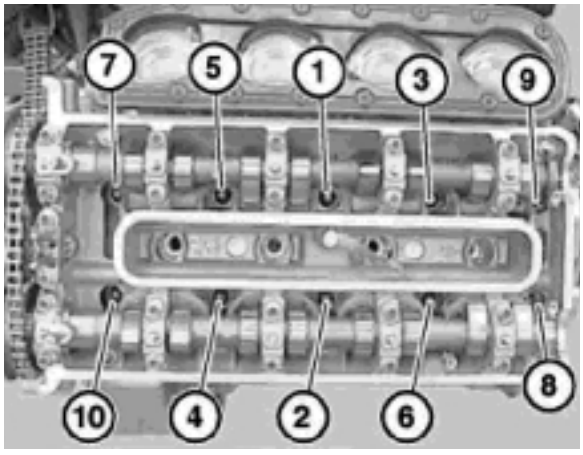
Camshaft Primary Drive: Primary drive is provided by a double-roller chain from the crankshaft to the intake camshafts on both banks.

The chain is guided by a centrally positioned V-shape deflection rail. Additionally, a straight rail is used on cylinder bank 5-8 and a curved chain tensioner rail with a hydraulic “self adjusting” tensioner on cylinder bank 1-4.



Camshaft Secondary Drive: Secondary drive is from the intake camshaft to the exhaust camshaft by a single roller chain (arrow). The chain is tensioned by a hydro-mechanical “self adjusting” tensioner (between the sprockets).

The oil supply for the chain tensioner also supplies the VANOS hydraulic units through a pressure control valve.



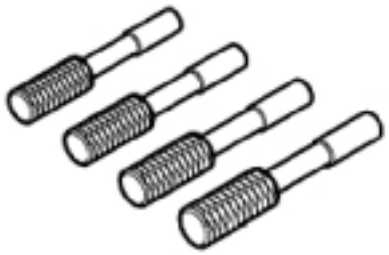
Camshafts: The four S62 cast iron overhead camshafts are hollow and are strengthened by heat treating the journals and cam lobes.

Each camshaft is supported by five bearings that are marked intake/exhaust and numbered for location.

The camshafts feature recesses that allow the cylinder head bolts to be removed without removing the shafts (head bolts 1 through 10 shown on the right).

The camshafts are not interchangeable, therefore they should be marked before disassembly.

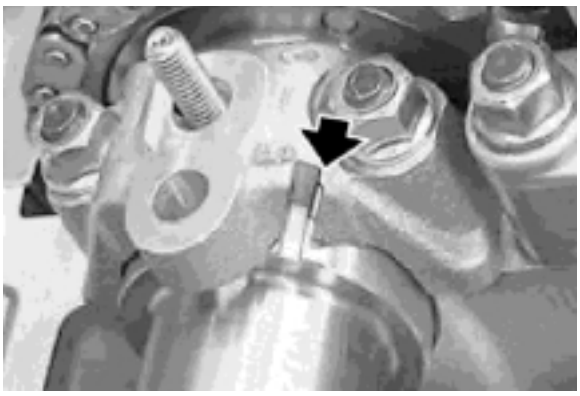
For installation and timing procedures, the camshafts are held in position by locking pins (Special Tools) that are inserted into the front camshaft bearing caps on both cylinder heads (as shown on the right).



Using an open end wrench to turn camshafts will allow the locking pins to be inserted with ease. Refer to the Repair Instructions for details on camshaft removal, installation and timing.

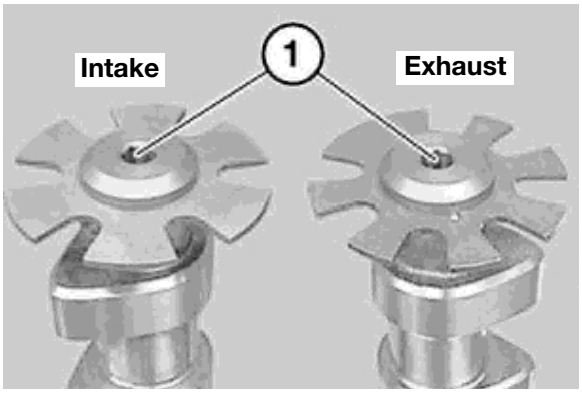
Caution: Remove locking pins before rotating camshafts!

When performing camshaft timing, a visual "sight" is provided on the front cam journal support cap and in the camshaft journal (for both intake and exhaust).



The two grooves should line up to verify correct timing.

An impulse wheel is mounted on the end of each camshaft for position detection (VANOS operation). The impulse wheels are secured by a removeable bolt (1).



The intake camshaft impulse wheels have 6 lugs and the exhaust camshaft impulse wheels have 7 lugs (including one large lug).

Valves and Valve Springs: The intake and exhaust valves are lightweight in design to reduce reciprocating mass. The valve diameter is:

1.	**Intake 35 mm**
2.	**Exhaust 30.5 mm**
3.	**Stem-Intake / Exhaust 6.0 mm**

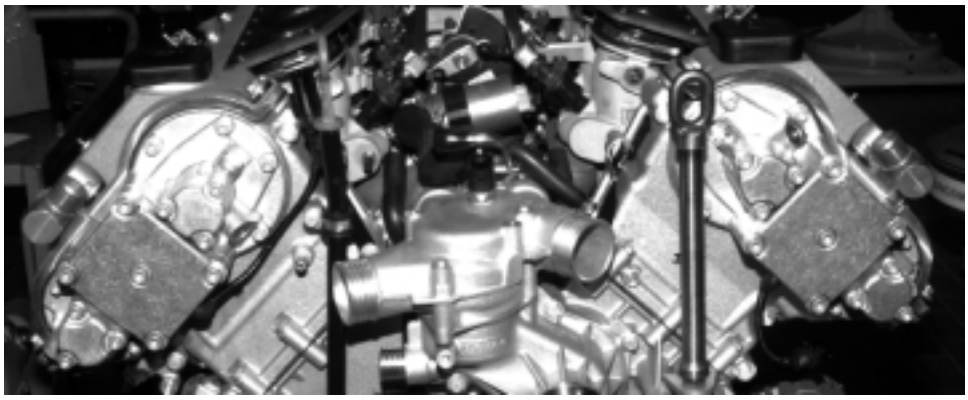
The S62 valves use single conical (tapered) valve springs and HVAs (hydraulic compensators) to actuate the valves. *Valve adjustment is not required.*

The springs are marked for correct installation due to the “cone” shape *(paint stripes facing down towards cylinder head).*

Notes:

VANOS

Performance, torque, idle characteristics and exhaust emissions reduction are improved by variable camshaft timing (VANOS). The S62 engine uses a double VANOS system for valve timing on both the intake and exhaust camshafts.



The S62 uses a high pressure (100 Bar) control system that ensures quick and reliable adjustments of the camshafts to meet the high performance requirements of the M Engines. The VANOS units are mounted directly on the front of the cylinder heads.

Each VANOS unit contains:

- High pressure radial oil pump (driven by the intake Camshaft)
- Two inlet solenoids
- Two outlet solenoids
- Two adjustment pistons
- Two hydraulically actuated adjustment shafts

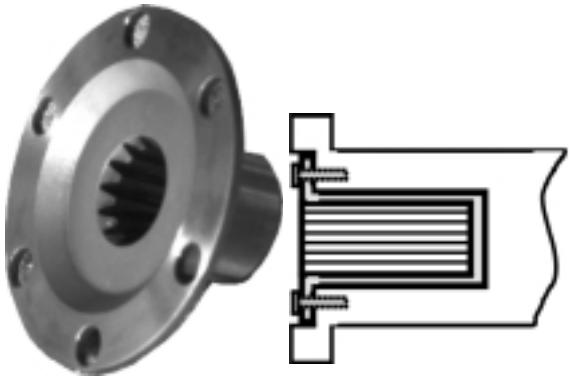
Two solenoids are required for each adjusting piston circuit, one for advancing and one for retarding the camshaft timing. The solenoids are controlled by the ECM.

The adjustment shafts contain two sets of splines that engage with:

1.	**Camshaft Sleeves (Straight Splines)**
2.	**Chain Driven Sprocket (Helical Splines)**

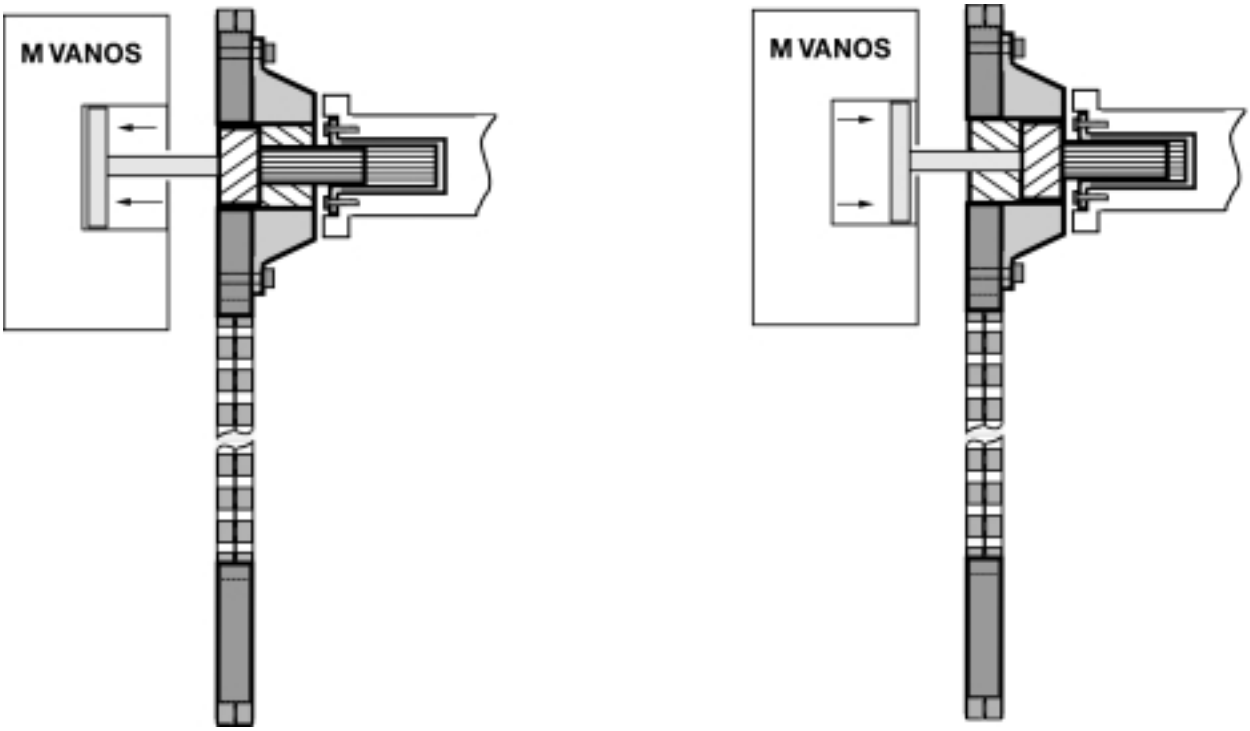
The adjustment shafts have a total stroke of 25 mm.

The camshaft sleeves are bolted to the end of the camshafts and engage with the straight spline of the adjustment shaft shown above.



The chain driven sprocket and spacer sleeve assembly is shown to the right (one assembly per camshaft). The sprocket engages with the helical splines of the adjustment shaft shown above.

The intake camshaft sprocket assembly has two drive “lugs” that must be aligned with the radial piston oil pump during installation.



VANOS mechanical operation is dependent on oil pressure applied to position the control pistons. The double VANOS camshafts are infinitely adjustable within the mechanical travel limits of the drive gears.

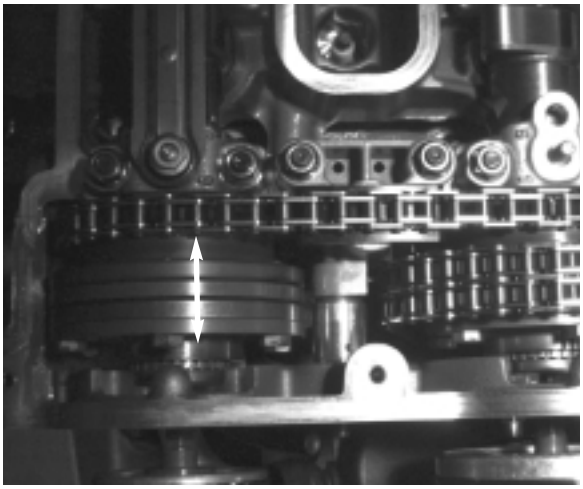
When oil pressure is applied to the control piston, the piston moves causing the splined adjustment shaft to move. The straight splines slide within the camshaft sleeve. The helical splines rotate the camshaft drive sprocket changing the position in relation to the camshaft position which advances/retards the camshaft timing.

The total adjustment range of the camshafts is 60º (as referenced to the crankshaft).

The “default” mechanical stop position without VANOS influence is:

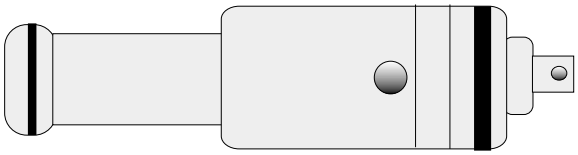
Intake Camshaft = Retarded
Exhaust Camshaft = Advance

Oil is supplied from the main gallery through the front of cylinder head (arrow) to the inlet pressure reducing valve.

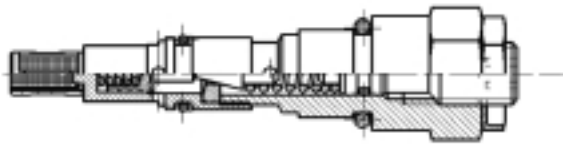


Pressure Reducing Valve: The pressure reducing valve supplies oil to the radial piston high pressure oil pump. It is located between the cylinder head and the VANOS unit.

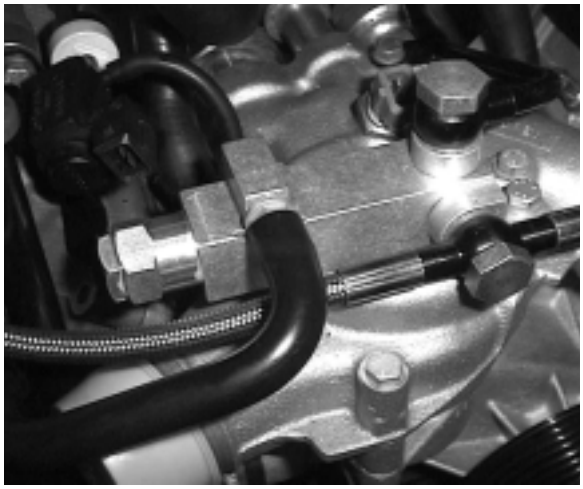
The valve ensures the oil pressure supply to the VANOS pump is 0.5 Bar regardless of the varying pressure from the main oil pressure gallery. The pressure reducing valve is pressed into the VANOS unit and secured by an “o-ring”.



100 Bar Pressure Regulating Valve: The 100 Bar pressure regulating valve regulates the pressure produced by the radial piston high pressure oil pumps.



The 100 Bar pressure regulating valve is mounted in the center of the cylinder block “V” on the thermostat housing.



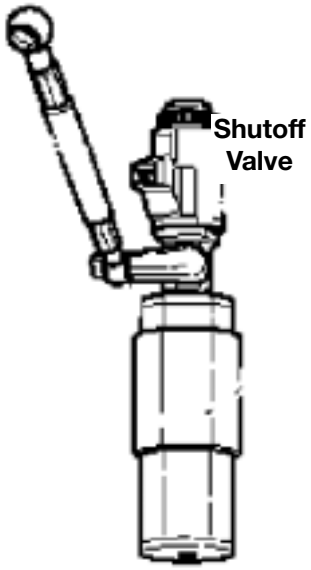
The valve ensures that the oil pressure for VANOS operation is maintained at 100 bar. One pressure regulator is used for both cylinder banks.

Note: The 100 Bar pressure regulating valve is not adjustable.

VANOS Accumulator: The VANOS accumulator ensures that there is a sufficient volume of oil under pressure to adjust the camshafts under all engine operating conditions.

The accumulator is Nitrogen charged and is located on the front of the 5 - 8 bank of the engine. It is connected to the VANOS oil pressure circuit by a high pressure line.

VANOS Accumulator with Electrical Shutoff Valve: The VANOS accumulator with an electrical shutoff valve was phased into production on 2001 MY S62 engines.



This production change addresses the customer complaint of a rattling noise (from the VANOS units) in the first few seconds after starting the engine. The VANOS hydraulics can cause rattling noises after the engine start due to the varying torque of the camshaft before sufficient VANOS oil pressure has built up.

When the engine is stopped, the oil runs out of the high-pressure chamber in the adjustment cylinder. This can cause the VANOS adjustment piston to move freely against the housing during startup.

The shutoff valve prevents this because it will close (without electrical power) to reserve a volume of oil under pressure in the accumulator when the igniton is switched off. Upon the next engine start, the valve will be opened by the ECM allowing the stored accumulator release to “prime” the VANOS assemblies with pressurized oil.

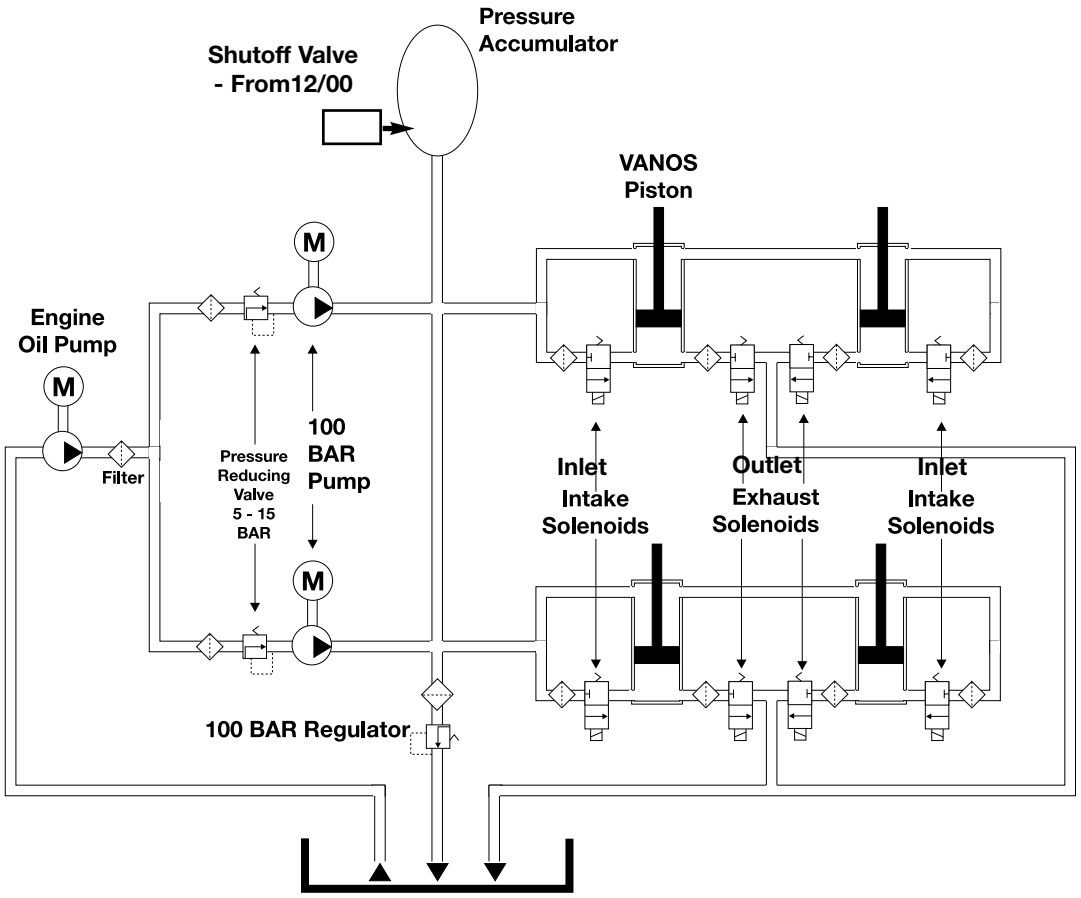
This noise has no effect on the engine's power output or durability.

The affected vehicles are:
- E39 (M5), E52 (Z8)

Manufacturing period:
- From the start of series production up to November 2000

In case of customer complaint on vehicles produced before 12/2000, Refer to the Service Information Bulletin. A shutoff valve may be retrofitted to the VANOS accumulator.

Note: There are two different retrofit kits depending on the vehicle production date.
- Retrofitting on vehicles from start of series production until August 2000.
- Retrofitting on vehicles from September 2000 until November 2000.



VANOS system hydraulic operation:

- When the engine starts, oil from the main engine oil pump is fed under pressure to the pressure reducing valves.

- The oil pressure is dropped to approximately 0.5 Bar and fed to the radial piston high pressure oil pumps.

- The pumps are driven by the intake camshafts and the 100 bar pressure is built up by the pressure regulating valve. The volume of pressurized oil is stored in the accumulator supplying both adjustment pistons. Both pistons are held in the default position by the high pressure oil.

- At the same time the high pressure oil is available at the inlet solenoids of both adjustment pistons.

- VANOS adjustment is carried out by the ECM pulsing the inlet and outlet solenoids to allow pressurized oil to the back side of the adjustment pistons. The surface area on this side of the piston is larger so that the oil pressure is greater and the adjustment piston will move causing the valve timing to change.

- The piston is connected to the adjustment shaft. As the piston moves, the shaft turns the helical splines varying the camshaft sprocket position in relation to the camshafts.

From 12/00 Production Date

- When the ignition is switched “off” the shutoff valve will close (without electrical power) to reserve a volume of oil under pressure in the accumulator. Upon the next engine start, the valve will be opened by the ECM allowing the stored accumulator release to “prime” the VANOS assemblies with pressurized oil.

CAUTION!

- *The VANOS system is under high pressure (100 Bar).*

- *The VANOS accumulator stores pressurized oil, do not energize the Shutoff Valve when the oil circuit (lines) is open!*

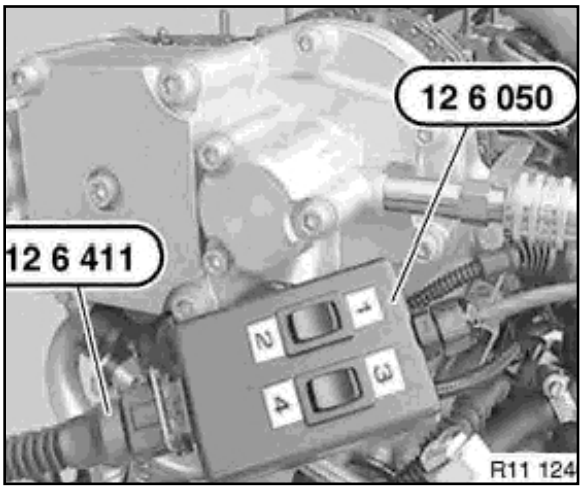
- *Consult the Repair Instructions before performing any repairs.*

Workshop Hints

The VANOS function test can be performed by using Special Tools:

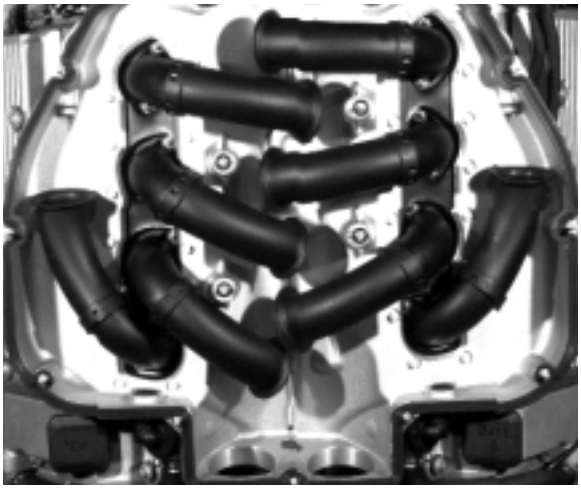
#90 88 6 126 411
#90 88 6 126 050
Regulated Compressed Air (2-8 bar)

Refer to the Repair Instructions for the VANOS function test procedures.



Intake Air Plenum: The large intake air plenum is designed for the maximum volume required for the S62 engine. Inside the intake plenum, each throttle valve has its own air funnel which is bolted to the individual throttle housing.

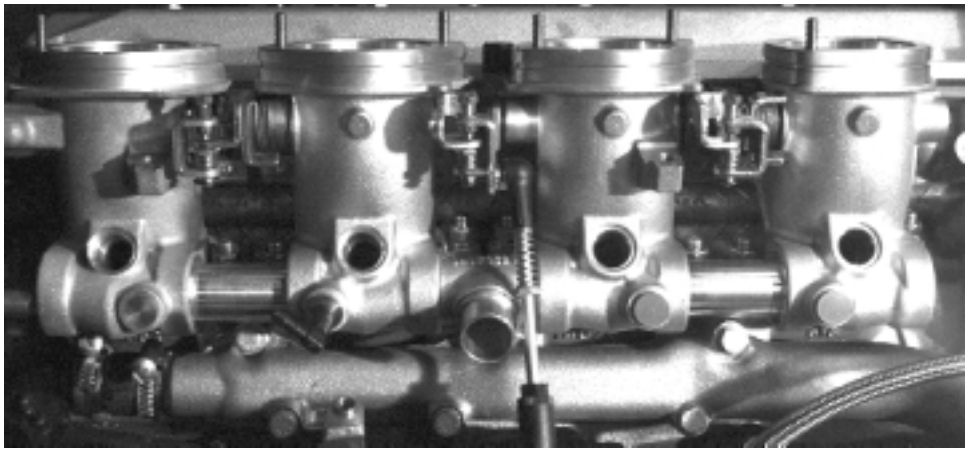
The air funnel positions are defined by the shape of the plenum. The funnels for cylinders 1 and 5 face rearward and the remaining funnels face inward.



The lower plenum is sealed to the upper cover by a perimeter gasket and four “o-rings” on the center support towers.

Caution: Remove attaching nuts and store away from intake plenum before lifting funnels from the throttle housings so they do not fall into the throttle housings!

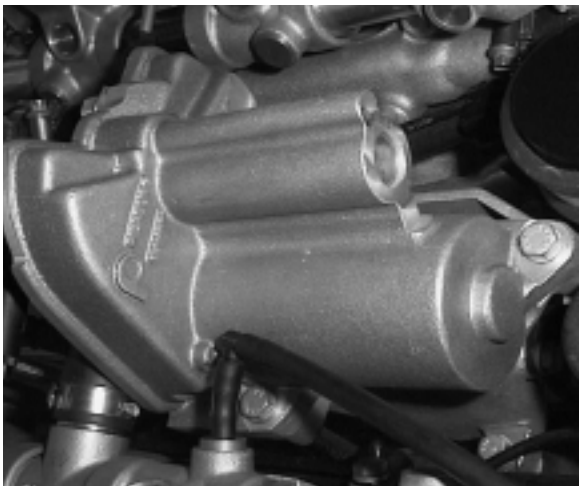
Intake Air System: The S62 engine uses eight individual throttle housings that are bolted directly to the cylinder heads. To ensure smooth and stable engine operation all eight throttles must be synchronized for an even distribution of the intake air.



One bank of four shown

Refer to the Repair Instructions for the procedure to adjust and synchronize the throttle housings.

Electronic Throttle Motor (EDR): All eight throttles are activated by one electric throttle motor (EDR).



The EDR motor is mounted in the “V” of the block and controls the throttles through two linkages. The ECM controls the EDR to open and close the throttle valves.

The throttle valves are fitted with mechanical return springs to close them when the EDR is not energized.

Idle Speed Actuator: A separate idle speed actuator (ZWD 5) is used to supply the idle air to all cylinders. The actuator supplies air to the base of the throttle housings which bypasses the throttle valves (plates) to maintain engine idle speed.

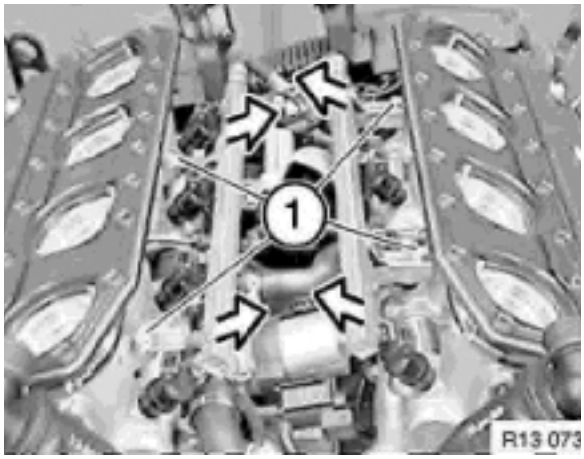
The idle speed actuator is mounted in the “V” of the block and is connected to the throttle valves through large air pipes linked between each throttle housing.

Fuel Supply: The fuel is supplied through a Non Return Fuel Rail System. This system is used on the S62 for TLEV compliancy. The fuel supply pressure is controlled by the 5 Bar fuel pressure regulator integrated in the fuel filter assembly (pressure test fitting at this point). The E39 M5 fuel filter assembly is located under the left front floor area (next to the frame rail).

The fuel exits the fuel pressure regulator supplying even fuel distribution to all fuel injectors due to a “T” connection feeding both fuel rails.

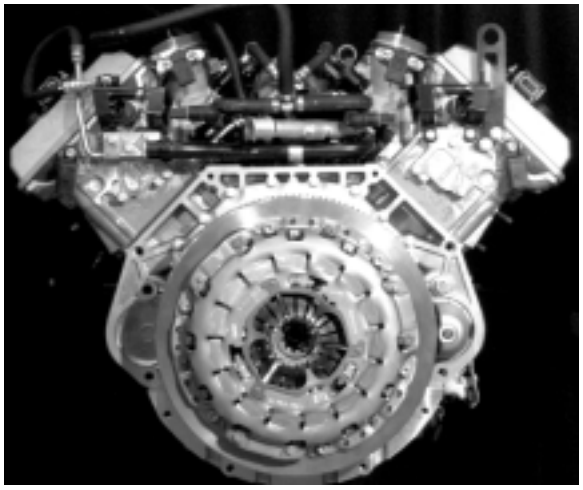
The fuel return line is located on the filter/regulator assembly which directs the unused fuel back to the fuel tank. The fuel tank hydrocarbons are reduced by returning the fuel from this point instead of from the fuel rail.

The Non Return Fuel Rails are secured to the throttle housings by two bolts (for each shown to the right #1).



The fuel rails provide even distribution and a volume of fuel for the injectors.

Clutch Assembly: The S62 clutch assembly is specially designed to transfer the high torque to the driveline and dampen vibrations throughout the rpm range.



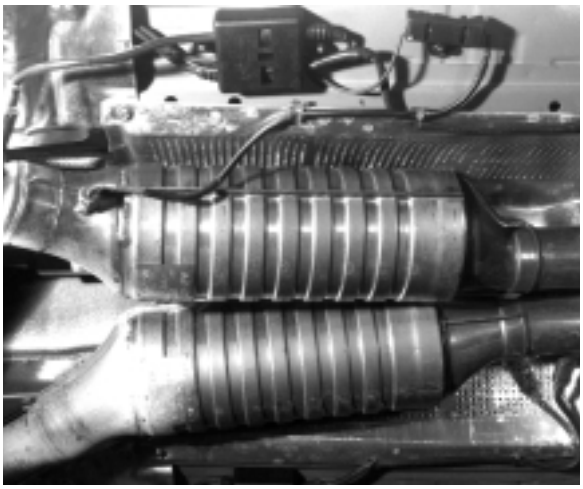
The clutch assembly consists of:

Weight Optimized Dampened Dual-Mass Flywheel
Diaphragm Type Self Adjusting Pressure Plate and Drive Disk

The incremental wheel is mounted to the flywheel for the engine speed, reference and Misfire Detection. The self adjusting clutch (SAC) has lower release forces for easier clutch operation (less pedal effort required).

Procedures for checking and replacing the self adjustment clutch including the Special Tools are found in the Repair Instructions.

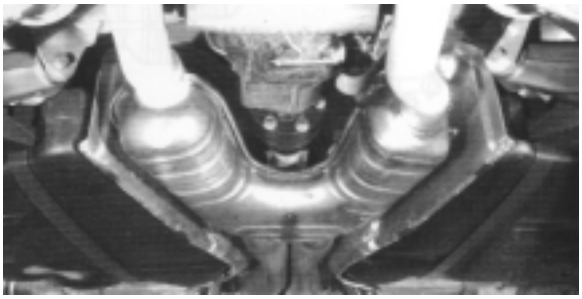
Exhaust System: The exhaust manifolds are stainless steel with an air gap insulation that allows the converters to warm up rapidly and reach their operating temperature.



Two metal monolith catalytic converters are used with pre and post catalyst oxygen sensors for OBD II compliance.

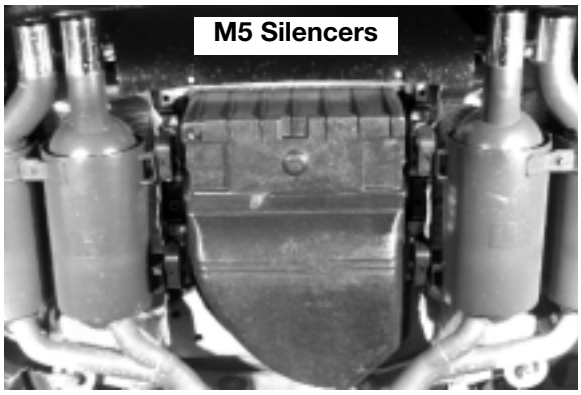
The left side catalyst contains an Exhaust Gas Temperature Sensor on vehicles produced up to 9/2000. Vehicles produced >9/2000 do not have this sensor. *Refer to the Service Information Bulletin on modifying early production-vehicles.*

The exhaust is combined in the one piece central silencer with two outlet openings at the rear which lead to the two main silencers.



Main Silencers: Four main silencers with individual outlets are used on the M5 to comply with international noise emission regulations.

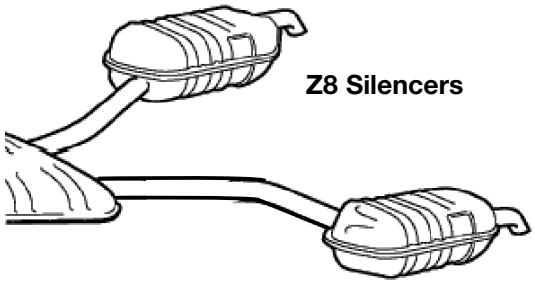
Due to the positioning and space requirements for the silencers, the floor pan of the luggage compartment is redesigned and the spare wheel has been eliminated.



M5 Silencers

The battery is mounted in the luggage compartment floor between the rear silencers as shown on the right.

The Z8 uses two rear silencers with individual outlets

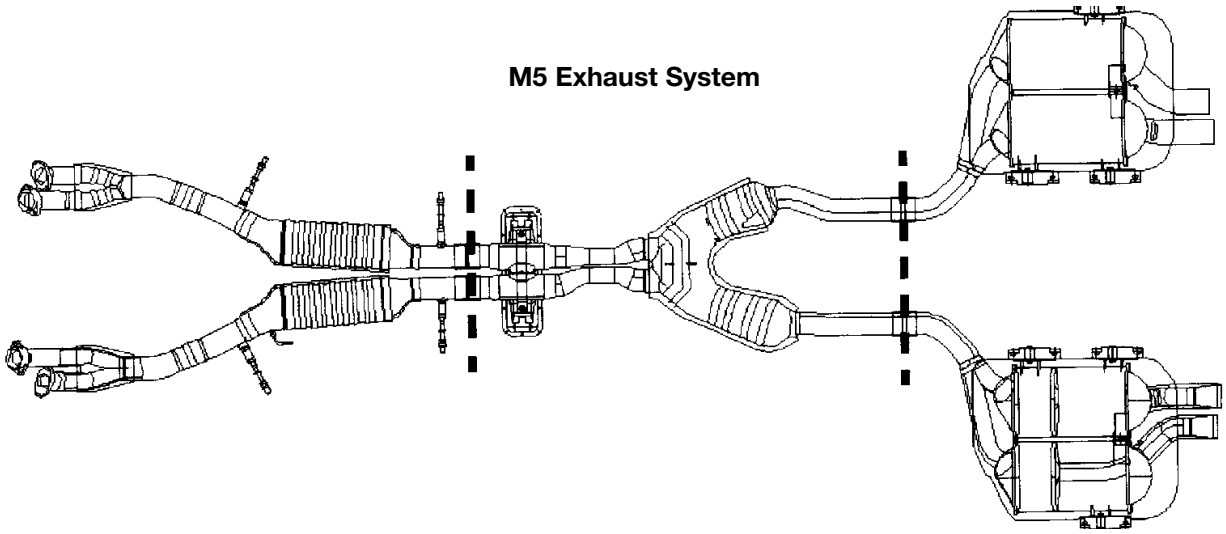


Z8 Silencers

For production purposes, the stainless steel exhaust system is a one piece component after the exhaust manifolds.

For repair purposes, the system is separated and sleeved in sections at specific points.

M5 Exhaust System



Review Questions

1. Why does the valve clearance not have to be adjusted on the S62? _____

   _____

2. The flywheel mounted incremental wheel on the S62 provides:

   _____ _____ _____

3. What does the term “cracked” connecting rod mean?

   _____

   _____

   _____

4. What is the function of the Scavenge Oil Pumps on the S62 and how do they affect oil pan removal? _____

   _____

   _____

5. What special tools are used to perform the VANOS function test?

   #_____ #_____

6. When installing the camshafts, the journal caps should be installed based on what markings?

   _____ _____

7. What is the purpose of the VANOS Accumulator with an Electrical Shutoff Valve?

   _____

   _____

   _____

8. What must be “aligned” with the radial piston high pressure oil pumps when installing the VANOS units? _____

9. Where is the fuel pressure tested on the E39 M5 and what is the nominal pressure?

   _____ _____ Bar

10. What sensor was deleted from S62 equipped vehicles produced after 9/2000?

    _____